RESEARCH SUMMARY

forest sciences
NELSON FOREST REGION

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Preliminary Height Expectations for Lodgepole Pine Plantations in the Nelson Forest Region

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- **Years to breast-height range from 4.5 to 6 years.**
- **Years to a height of 3 metres range from 7.8 to 10.5 years**

INTRODUCTION

Knowledge of expected height growth of newly established plantations is important in many aspects of forest planning. Achievement of free-growing status and subsequent green-up considerations affect harvesting scheduling through adjacency rules and, ultimately, allowable cut calculations. The Timber Supply Review process has shown the latter to be particularly sensitive to variations in the number of years used for green-up achievement. Equivalent Clear-cut Area calculations for hydrological recovery are also highly dependent on plantation height growth.

METHODS

The data used for this report are from a lodgepole pine provenance study (EP657.06). Planted in 1974 at 15 locations in the Nelson Forest Region and measured at regular intervals for 20 years, the study contains 60 provenances at each location, some with great geographic displacement. Only provenances originating in or adjacent to the Nelson Region were used in this summary. In addition, two locations were discarded. One had very heavy rabbit-caused mortality and the second had developed seriously abnormal growth. Thus the growth of 13 provenances at 13 locations is

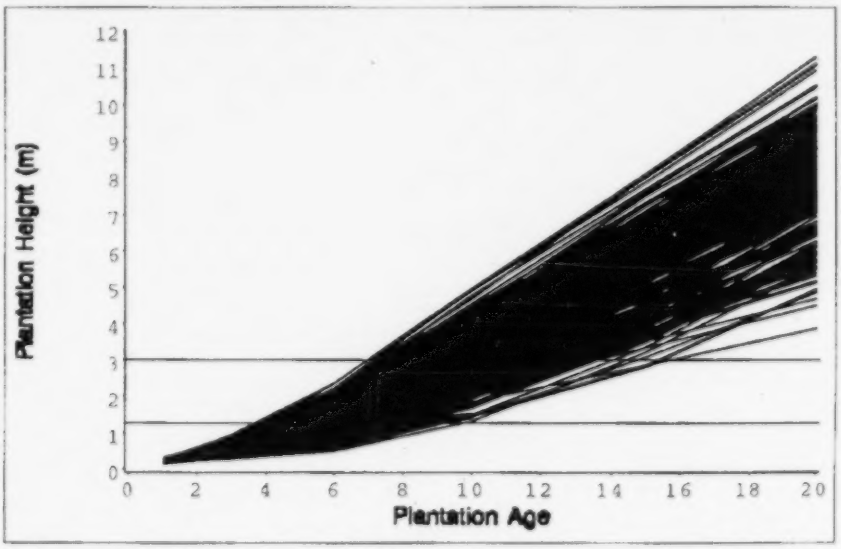

Figure 1 Growth of all provenances at all locations. Reference lines are drawn at default-green-up (3 m) and breast-height (1.3 m)

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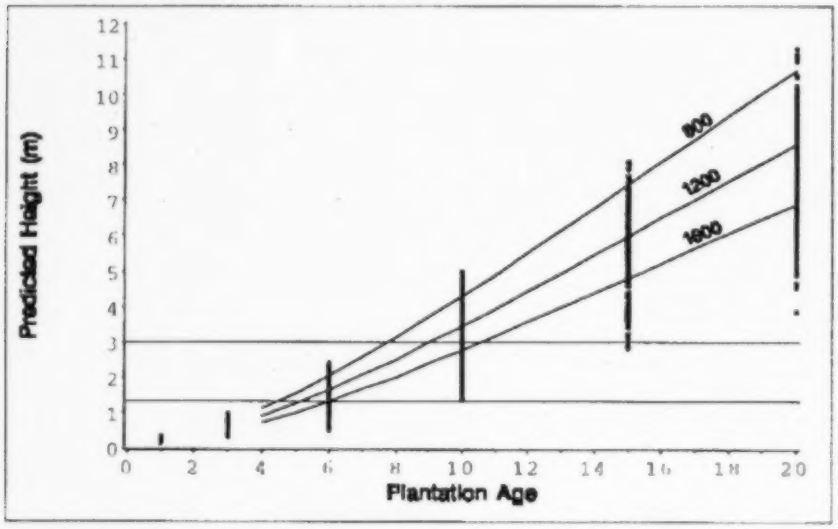

Figure 2 Predicted mean heights for lodgepole pine plantations for elevations 800, 1200 and 1600 m. Reference lines drawn at default green-up (3 m) and breast-height (1.3 m).

summarized here.

Sampling is sparse, but geographically well distributed across the region. Locations sampled range from 800m to 1800m, with the majority of locations between 1100m and 1500m. The 13 locations also represent 10 different biogeoclimatic sub-zones. Of the 13, 12 had been burnt less than 3 years before planting, and vegetation was controlled at all locations before it could become a concern.

At each location, each provenance is represented by two randomly located plots, each containing nine trees. The mean height for each plot was used as input into the modelling process. Thus for any location and age, each provenance is represented by two mean heights. The resulting growth segments for each location, provenance, and plot are shown in Figure 1.

RESULTS

In common with standard growth and yield procedures, all height-age points were used for model development. The highest-elevation plantation (1810m) was measured for only the first 10 years, but the data were retained for this analysis; however, due to incompleteness of the high-elevation data, results are reported to only 1600m. The best fit of the data was to a combined exponential and power function (3) of the form:

$$height = a \times age^{b} \times e^{(c \times age + d \times elevation)}$$

Model coefficients are shown in Table 1. Predicted plantation mean heights for three elevations are shown graphically in Figure 2 and presented in Table 2.

DISCUSSION

Based on this model, the estimated number of years needed to achieve breast-height at 800, 1200, and 1600m are 4.5, 5.2, and 6 years, respectively.

When predicted values from this model are compared to predicted mean heights from TASS (2), the shapes and ranges of the two models are comparable. Three Regeneration Performance Assessment (RPA) surveys conducted between 1990 and 1994 provided data for modelling growth expectations in spruce plantations (4). These same surveys included just 17 lodgepole pine plantations. This was judged insufficient data on which to base a model, but, an attempt to fit data from these 17 plantations using the coefficients in Table1, produced a good fit (adjR^2=0.75) with both shape and range corresponding well. Both comparisons suggest that this model adequately describes the range of variation experienced in the field.

Aspect and slope are currently not considered in the model. Observation suggests that incorporation of these factors into the model should improve the relationships developed. These data are available, but with only 13 sites in 10 biogeoclimatic subzones we decided that there was insufficient depth to attempt to include them in the model. Similarly, latitude (1), and soil moisture and soil nutrients (6) have also been shown to significantly affect site index calculations. Again, the limited range of sites in the data base and the circum-mesic nature of all plantations precluded consideration of these factors. Soil disturbance on certain sites (5) and stand density (7) have also been shown to negatively affect height growth. These factors were also not considered since the plantations were all established on uniformly prepared sites and at rigorously maintained densities (square spacing at 2.5m).

The highest-elevation plantation with complete data is at 1560m. Measurements at the one plantation at 1810m

a	b	c	d	adj R^2	SEE(m)
0.202205	1.605413	-0.02005	-0.00055	0.9443	0.687

adj R^2 is the proportion of the total variation accounted for by the model adjusted for the complexity of the model.

SEE is standard error of the residuals.

Table 1 Model coefficients

Plantation age (years)	Elevation (m)		
	800	1200	1600
4	1.11	0.89	0.72
5	1.56	1.25	1.01
6	2.05	1.65	1.32
7	2.58	2.07	1.66
8	3.13	2.51	2.02
9	3.70	2.97	2.39
10	4.30	3.45	2.77
11	4.91	3.94	3.16
12	5.53	4.44	3.57
13	6.17	4.95	3.98
14	6.81	5.47	4.39
15	7.46	5.99	4.81
16	8.11	6.51	5.22
17	8.76	7.03	5.64
18	9.41	7.55	6.06
19	10.06	8.08	6.48
20	10.71	8.59	6.90

Table 2 Predicted mean heights (m) for lodgepole pine plantations in the Nelson Forest Region based on analysis of height growth of selected provenances in EP657.06.

were discontinued after the tenth year because of poor performance. For these reasons, extrapolation to elevations above 1600m are not shown and the user is cautioned against attempting this. Similarly, extrapolation beyond 20 years is not recommended.

Height criteria for green-up achievement vary with resource unit objectives and base assumptions for each Timber Supply Area. Green-up heights can thus vary from the 3m default up to 20m, when visual quality, wildlife habitat, or watershed values are significant planning features. The models presented here provide a method of determining green-up time for resource units where heights up to 10m (for low-elevation plantations, less for higher-elevation plantations) are used as green-up height and lodgepole pine is the leading species. Because attempted extrapolations to heights above 10m proved unreliable, different strategies will be required to develop age estimates for planning units with taller green-up requirements.

In addition to harvest scheduling applications, these models can be used as standards to help answer other silvicultural questions, such as:

- Does the measured height of this plantation meet the standards?
- Why is the plantation performing below standard?
- How many other plantations are below standard, and what are the implications of this non-achievement?
- Is a silvicultural treatment available that will enable the plantation to achieve these standards?

The performance of a plantation is determined by many inter-related factors, many of which cannot be isolated using the RPA approach. However, benchmark averages such as those presented here can assist in the diagnosis of problem plantations and in the development of techniques for program improvement, while providing a standard for plantation performance assessment.

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